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Stand Ratings for Spruce Beetles

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Engelmann spruce-subalpine fir (*Picea engelmannii* Parry and *Abies lasiocarpa* (Hooker) Nuttall, respectively) stands can be rated for potential spruce beetle (*Dendroctonus rufipennis* (Kirby)) outbreaks on the basis of physiographic location, tree diameter, basal area, and percentage of spruce in the canopy.

Keywords: *Dendroctonus rufipennis, Picea engelmannii.*

Background

Spruce beetles are a major mortality factor in unmanaged mature stands of Engelmann spruce. They have periodically depleted the dominant and codominant trees, and changed the species composition where subalpine fir is a stand component. Infestations commonly develop in windthrown trees, and spread to standing trees.

Historically, forest administrators have approached the management of spruce beetle populations with a post mortem attitude. Most infestations reached outbreak status and killed substantial numbers of trees before action was initiated. Then attempts were made to control populations through application of insecticides and/or salvage logging of the infested trees. Very few stands received preoutbreak management actions to reduce or eliminate the tree mortality from spruce beetle outbreaks.

While this approach may have been satisfactory 50 years ago, it is unsatisfactory today. The nation is demanding more intensive management and use of the publicly owned forests as well as minimizing these vast tree losses to beetle outbreaks. Public concern is also evident in the increasing involvement of government agencies with the preparation of long-range management plans and environmental impact statements. These reports frequently incorporate information about the effects of spruce beetles on spruce-fir stands and relationships between stand conditions and beetle outbreaks, so that the impact of the beetles can be minimized.

To respond to these land management concerns, forest managers need a method of identifying potential outbreak areas. With such a method, they could direct preoutbreak actions to high-priority stands, and thereby reduce the number as well as the severity of future outbreaks. We believe a suitable stand rating plan can now be generated by integrating existing information scattered in different printed references. These references are Alexander (1967), Knight et al. (1956), Massey and Wygant (1954), and Schmid and Hinds (1974).

Development of the Stand Rating Plan

From Knight et al. (1956, p. 4), we use the first three susceptibility categories: spruce in creek bottoms, better stands of spruce on benches and high ridges, and poorer stands on benches and high ridges. These categories are modified, integrated into Alexander's (1967) site indexes, and listed in table 1

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Table 1.--Risk categories for potential spruce beetle outbreaks for each stand characteristic

Risk category[1]	Physiographic location	Average diameter of live spruce above 10 inches d.b.h.	Basal area	Proportion of spruce in canopy
		Inches d.b.h.	*Ft²*	*Percent*
HIGH (3)	Spruce on well-drained sites in creek bottoms	>16	>150	>65
MEDIUM (2)	Spruce on sites with site index of 80 to 120	12-16	100-150	50-65
LOW (1)	Spruce on sites with site index of 40 to 80	<12	<100	<50

[1] Number in parentheses indicates arbitrary value to be used in calculating stand priority, and is used only for convenience.

as physiographic locations. The new susceptibility categories become (1) spruce on well-drained sites in creek bottoms, (2) stands on sites with an index of 80 to 120, and (3) stands on sites with an index of 40 to 80. Since spruce on well-drained sites in creek bottoms could be included in the better-than-average sites, the separation of this category may seem unjustified. Because numerous infestations appear to have originated near creek bottoms, we feel this separation is valid. The latter two categories of Knight et al. (1956) pertain to the species composition of the stand, and therefore fit more appropriately in Schmid and Hinds' (1974) characteristic of percentage of spruce in the canopy.

Information on tree diameters is drawn from Massey and Wygant (1954), and unpublished data gathered by Schmid and Hinds. Massey and Wygant (1954, p. 13-14) indicated that the average diameter of the infested trees in the White River outbreak decreased from 21 to 17 to 15. As the outbreak began to terminate, the average diameters of living trees was about 13 inches. Unpublished information from Schmid and Hinds' study indicates that the average diameter at breast height (d.b.h.) of the spruce prior to the outbreak was about 16 inches when only trees above 10 inches d.b.h. were considered. Thus, the diameter information is subdivided into three categories: above 16 inches, 12 to 16 inches, and less than 12 inches.

Finally, the stand basal area and percentage of spruce in the canopy is derived from Schmid and Hinds (1974). This latter category in the rating plan also includes information from the tree susceptibility priorities of Knight et al. (1956).

Determining Risk Ratings for Particular Stands

Most forest managers will have information on these four stand characteristics available from their stand compartment files. It is then a simple matter to compare the actual stand information with the risk value in table 1. For example, the manager compares the site data with the risk categories of the physiographic location characteristic and classifies the stand as high, medium, or low risk (3, 2, or 1 rating) for that particular characteristic. He does this for each characteristic and then adds these rating values together. The total becomes the stand risk value which is used to classify the stand as having a high, medium, or low outbreak potential.

To calculate the rating for a hypothetical stand, assume these characteristics: (1) stand on a site with an index of 100, (2) average d.b.h. of the spruce of 17 inches, (3) basal area of the stand equals 155 ft² per acre, and (4) 70 percent of the canopy is spruce. Comparing these characteristics to the risk ratings in table 1, values of 2, 3, 3, and 3 are obtained for the respective characteristics. Adding these together gives a value of 11. The stand risk value of 11 is then translated into a potential outbreak rating:

Stand Risk Value	Potential Outbreak Rating
11-12	High
7-9	Medium
4-5	Low

The value of 11 gives the stand a high rating. If the value should be 4 or 5, the stand would receive a low rating; 7 to 9 would give it a medium rating.

Any arrangement of the different combinations of the four characteristic ratings shown below will give the risk value in parentheses:

Low (4-5)	**Medium (7-9)**	**High (11-12)**
1,1,1,1	1,3,2,1 2,2,2,1	3,3,3,3
1,1,2,1	1,3,3,1 2,2,2,2	3,2,3,3
	3,2,1,2 3,2,1,3	
	2,2,3,2	

Other Factors to Consider

There are two obvious voids in the system—one between the low and medium categories, and one between the medium and high categories. We believe these are "intermediate" areas where the rating of a stand legitimately falls between two more definitive categories. For example, a set of stand characteristics rating 2,1,2,1 or any combination of those values results in a stand risk value of 6:

Intermediate (6)	**Intermediate (10)**
1,1,3,1	3,3,3,1
2,1,2,1	3,3,2,2

Since half of the values are medium risk and the other half are low risk, the stand is midway between a low and medium outbreak rating. Should it rate low or medium? We believe it is intermediate, not distinctly in either category and needs further examination. Some sequential sampling plans for insect populations have similar voids, and the population is simply assigned to the next higher category. This solution could be used with this system, but we purposely left these voids because we believe they provide an ideal opportunity for the forest land manager and forest entomologist to work together, use their professional judgment, and derive an accurate stand rating.

We also recognize that the four stand characteristics in our method represent only a fraction of the factors that could be used. The forest manager may have information on windthrow potential, diameter growth rate, etc., from his own experience or from other published sources (such as Alexander 1973, 1974) which he can also consider in deciding whether the stand should be given a higher or lower rating. It is in this area where good experience and professional judgment are most beneficial.

Forest managers will ask "What size stand can be rated under this system?" In answering this question, we must first define a stand. We did so by paraphrasing the definition used by the Resource Inventory Project of Region 2, USFS (Forest Service Handbook): "A stand is a tree community possessing sufficient uniformity as regards timber type, age class, risk class, vigor, stand-size class and stocking class as to be distinguishable from adjacent communities and thus form a silvicultural unit." The rating system obviously works whether an area is 10,000 acres or 100 acres, as long as each area can be considered a stand. If an area does not meet the definition, the rating plan is not applicable.

Resource Inventory Projects in the Central Rockies are classifying the spruce-fir forests; stands in Colorado range in size from 40 to 200 acres. Unfortunately, some areas in the Central Rockies have yet to be delineated into stands so that areas of 10,000 acres or more, comprised of many stands, have not been classified. What can the forest manager do to circumvent this problem, and gain some type of rating for his stands? Two alternatives exist. First, apply the plan to the most susceptible part of the total acreage, and use the rating for the whole compartment. Since large areas such as drainages would probably be comprised of stands with high to low potential outbreak conditions, the total acreage would receive a high rating. This would lead to many areas with high ratings, and eliminate the value of the plan. In the second alternative, the land manager could apply the system to each of the different stands within the unit, derive an outbreak rating for each, and then average the ratings for the entire unit. This alternative is better than the first, but still does not fully utilize the system. Both alternatives compromise the system to the point where its usefulness is greatly reduced.

The system logically seems to conflict with the management objective of timber production. Since large spruce in stands of more than 65 percent spruce in the canopy and 150 ft^2 of basal area per acre constitute a high potential outbreak condition, their removal should lower the outbreak potential of the stand. However, their removal eliminates the major source of lumber. We recognize this conflict but suggest that the intent of the rating system is to identify the outbreak potential of each unmanaged stand, rather than to tell the manager how to manage. The manager decides whether to cut or leave such trees. He can leave the stand uncut, but he does so realizing that those trees are carried under high risk.

As mentioned previously, this system originates from several different sources not from a definitive study with the rating system as its objective. It has not been field tested, and therefore will probably be refined as it is used. Despite these disadvantages, we feel it provides the forest manager with another valuable tool for managing spruce forests and beetle populations.

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